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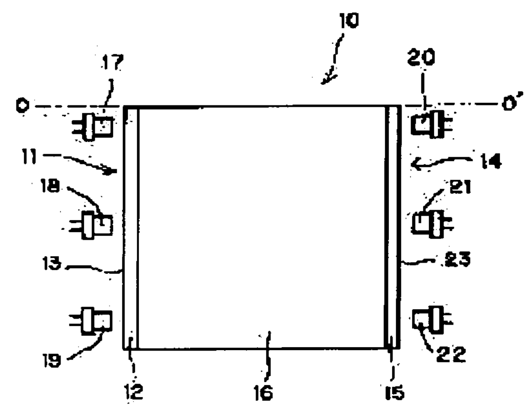
(54) OPTICAL BUS AND SIGNAL PROCESSOR

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain an optical bus with high resistance to dust or like and environment change such as temperature change in which the free attachment or detachment of a circuit board can be easily attained according to the extendibility of a system by diffusing an incident signal beam to an optical bus main body by a signal beam incident part, and diffusing and a signal beam propagated in the optical bus main body by a signal beam emitting part.
SOLUTION: An optical bus 10 is provided with a signal beam incident part 11, signal beam emitting part 14, and light transmitting layer 16 constituting an optical bus 10 main body for propagating the incident signal beam to the signal beam emitting part 14. A first light diffusing layer 12 of the signal beam incident part 11 diffuses the incident signal beam to the light transmitting layer 16. This light diffusing layer 12 is adhered to the edge face of the light transmitting layer 16. Also, a second light diffusing layer 15 of the signal beam emitting part 14 diffuses a signal light propagated through the light transmitting layer 16, and emits it from the signal beam emitting part 14. This light diffusing layer 15 is adhered to the edge face of the light transmitting layer 16 at an opposite side to the edge face to which the light diffusing layer 12 is adhered.



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CLAIMS

[Claim(s)]
[Claim 1] The signal light incidence section to which incidence of the signal light is carried out, and the signal light outgoing radiation section to which outgoing radiation of the signal light is carried out, While having the 1st optical diffusion means which turns the signal light in which is the optical bus which has the optical bus body which spreads the signal light which carried out incidence from said signal light incidence section in the signal light outgoing radiation section, and said signal light incidence section carried out incidence in an optical bus body, and diffuses it The optical bus characterized by having the 2nd optical diffusion means which said signal light outgoing radiation section diffuses the signal light which has spread the inside of an optical bus body, and carries out outgoing radiation from this signal light outgoing radiation section.
[Claim 2] The 1st circuit board in which the circuit which generates the signal which makes the signal light by which outgoing radiation is carried out from the signal light outgoing radiation edge which carries out outgoing radiation, and this signal light outgoing radiation edge support a base and signal light was carried, The signal light incidence section which was fixed to the 2nd circuit board in which the circuit which performs signal processing based on the signal which the signal light which carried out incidence supports from the signal light incidence edge which carries out incidence of the signal light, and this signal light incidence edge was carried, and said base and to which incidence of the signal light is carried out, It has the signal light outgoing radiation section to which outgoing radiation of the signal light is carried out, and the optical bus body which spreads the signal light which carried out incidence from said signal light incidence section in the signal light outgoing radiation section. It has 1st optical diffusion means by which said signal light incidence section turns the signal light which carried out incidence in an optical bus body, and diffuses it. The optical bus which comes to have the 2nd optical diffusion means which said signal light outgoing radiation section diffuses the signal light which has spread the inside of an optical bus body, and carries out outgoing radiation from this signal light outgoing radiation section, And while the signal light outgoing radiation edge in which it was carried by said 1st circuit board is combined with said optical bus in said signal light incidence section, said the 1st circuit board and said 2nd circuit board The signal processor characterized by equipping the condition that the signal light incidence edge carried in said 2nd circuit board is combined with said optical bus in said signal light outgoing radiation section with the base fixed part fixed on said base.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical bus which bears propagation of a lightwave signal, and the signal processor which performs signal processing including transmission and reception of the data using the optical bus.
[0002]
[Description of the Prior Art] By development of a very large-scale integrated circuit (VLSI), the circuitry of the circuit board (daughter board) used with data processing system has been increasing substantially. Since the number of signal connection to each circuit board increases as circuitry increases, the juxtaposition architecture which needs many connection connectors and path cords has been adopted as the data bus board (mother board) which connects between each circuit board (daughter board) by the bus structure. Although improvement in the working speed of a juxtaposition bus has been achieved by advancing parallelization by multilayering and detailed-izing of a path cord, the processing speed of a system may be restricted with the working speed of a juxtaposition bus by the signal delay resulting from the capacity between connection wiring, or connection wiring resistance. moreover, the electromagnetism by the densification of juxtaposition bus connection wiring -- the problem of a noise (EMI:Electromagnetic Interference) also serves as big constraint to the improvement in processing speed of a system.
[0003] In order to solve such a problem and to aim at improvement in the working speed of a juxtaposition bus, using the system intrinsic-light connection technique called an optical interconnection is examined. The outline of an optical interconnection technique "Teiji Uchida, The 9th time Circuit mounting academic lecture convention 15C01, pp.201 - 202" and "H.Tomimuro etal., "Packaging Technology for Optical Interconnects", and IEEE Tokyo No.33 The technique of various gestalten is proposed according to the content of the structure of a system as indicated by pp.81-86, 1994", and "the Wada **** electronics April, 1993 issue and pp.52-55."
[0004]
[Problem(s) to be Solved by the Invention] To JP,2-41042,A, among various optical interconnection techniques of a gestalt by which the conventional proposal was made The example which applied the optical data transmission method using a high speed and luminescence/light-receiving device of high sensitivity to the data bus is indicated. There Luminescence/light-receiving device is arranged to front flesh-side both sides of each circuit board, and the serial light data bus for the loop transmission between each circuit board which combined spatially between luminescence/light-receiving devices on the adjoining circuit board which was included in the system frame with light is proposed. By this method, light / electric conversion of the signal light sent out from a certain circuit board of one sheet is carried out by the adjoining circuit board, and it is further transmitted among all the circuit boards included in the system frame, repeating [the electrical and electric equipment / optical conversion is shortly carried out by that circuit board, each circuit board is arranged by the serial one by one as signal light is sent out to the circuit board which adjoins a degree, and] light / electric conversion, and the electrical and electric equipment / optical conversion on each circuit board. For this reason, a signal transduction rate receives that constraint at the same time it is dependent on the light / electric conversion rate of light-receiving/luminescence device, and the electrical and electric equipment / optical conversion rate arranged on each circuit board. Moreover, since the optical coupling by light-receiving/luminescence device arranged on each circuit board between which free space was made to be placed is used, it is necessary for the data transmission between each circuit board to have performed optical alignment of luminescence/light-receiving device arranged to adjoining circuit board table flesh-side both sides, and for all the circuit boards to have joined together optically. Furthermore, since each

circuit board is combined through free space, the interference between the adjoining optical data transmission lines (cross talk) occurs, and poor transmission of data is expected. Moreover, when signal light diffuses according to the environment in a system frame, for example, dust etc., it is also expected that poor transmission of data occurs. Furthermore, since each circuit board is arranged at the serial and connection breaks off there when one of boards is removed, the excessive circuit board for compensating it is needed. That is, the circuit board cannot be detached and attached freely but there is a problem that the number of the circuit boards will be fixed.
[0005] As a data transmission technique between the circuit boards in which the free space other than these was used, in JP,61-196210,A, the plate which has the 2nd parallel page and which was counterposed by the light source is provided, and the method which combines between the circuit boards optically through the optical path constituted by the diffraction grating and reflective component which have been arranged on the plate front face is indicated. By this method, it cannot transmit to one point which had the light emitted from one point fixed, but there is a problem that between [no] circuit boards is comprehensively connectable like an electric bus. Moreover, since free space is used, complicated optical system is needed, since alignment etc. is difficult, the interference between adjoining optical transmission lines resulting from a location gap of an optical element (cross talk) occurs, and poor transmission of data is expected. Furthermore, since the initial entry between the circuit boards is determined by the diffraction grating and reflective component which have been arranged on the plate front face, it has various problems which cannot take out and insert the circuit board freely but say that expandability is low.
[0006] Resistance [as opposed to dust etc. in view of the above-mentioned situation] of this invention is high, it is strong also to environmental variations, such as a temperature change, and free attachment and detachment of the circuit board aim it at offering easily a possible optical bus and the signal processor with which the optical bus was adopted according to the expandability of a system.
[0007]
[Means for Solving the Problem] Although it is possible to adopt the optical bus which diffuses and spreads the signal light which carried out incidence as a means to attain the above-mentioned object, when such an optical bus is produced simply, there is a possibility that the signal luminous intensity by which outgoing radiation is carried out from one certain outgoing radiation location in the incidence location of signal light may produce the need of detecting large dispersion and a large signal light of a dynamic range. Therefore, although it is necessary to perform the circuit design which suited the large dynamic range, the circuit design which suited the large dynamic range is serious, and has lowering of S/N, and the problem of causing a cost rise.
[0008] Then, the signal light incidence section to which the optical bus of this invention is an optical bus by the incidence location and outgoing radiation location of signal light which lessens change of signal luminous intensity by which outgoing radiation is carried out further while attaining the above-mentioned object, and incidence of the signal light is carried out, It is the optical bus which has the signal light outgoing radiation section to which outgoing radiation of the signal light is carried out, and the optical bus body which spreads the signal light which carried out incidence from the above-mentioned signal light incidence section in the signal light outgoing radiation section. While having an optical diffusion means by which the above-mentioned signal light incidence section turns the signal light by which incidence was carried out in an optical bus body, and diffuses it, it is characterized by having the optical diffusion means which the above-mentioned signal light outgoing radiation section diffuses the signal light which has spread the inside of an optical bus body, and carries out outgoing radiation from this signal light outgoing radiation section.
[0009] Moreover, the signal processor of this invention (1) base (2) signal light It is based on the signal which the signal light which carried out incidence from the signal light incidence edge which carries out incidence of the 1st circuit board (3) signal light in which the circuit which generates the signal supported by the signal light by which outgoing radiation is carried out from the signal light outgoing radiation edge which carries out outgoing radiation, and this signal light outgoing radiation edge was carried, and this signal light incidence edge supports. Signal processing The signal light incidence section which was fixed to the 2nd circuit board (4) above-mentioned base with which the circuit to perform was carried and to which incidence of the signal light is carried out, It has the signal light outgoing radiation section to which outgoing radiation of the signal light is carried out, and the optical bus body which spreads the signal light which carried out incidence from the above-mentioned signal light incidence section in the signal light outgoing radiation section. It has an optical diffusion means by which the above-mentioned signal light incidence section turns the signal light by which incidence was carried out in an optical bus body, and

diffuses it. The 1st circuit board of the optical bus (5) above and the 2nd circuit board of the above which come to have the optical diffusion means which the above-mentioned signal light outgoing radiation section diffuses the signal light which has spread the inside of an optical bus body, and carries out outgoing radiation from this signal light outgoing radiation section While the signal light outgoing radiation edge carried in the 1st circuit board of the above is combined with the above-mentioned optical bus in the above-mentioned signal light incidence section It is characterized by equipping the condition that the signal light incidence edge carried in the 2nd circuit board of the above is combined with the above-mentioned optical bus in the above-mentioned signal light outgoing radiation section with the base fixed part fixed on the above-mentioned base.
[0010]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained. Drawing 1 is the top view showing the optical bus of the 1st operation gestalt of this invention. This optical bus 10 has the optical transmission layer 16 which spreads the signal light which carried out incidence from the signal light incidence section 11 to which incidence of the signal light is carried out, the signal light outgoing radiation section 14 to which outgoing radiation of the signal light is carried out, and the signal light incidence section 11 in the signal light outgoing radiation section 14 and which makes optical bus 10 body. The signal light incidence section 11 is equipped with the 1st optical diffusion layer 12 which turns to the optical transmission layer 16 the signal light which carried out incidence, and diffuses it, and has pasted up this optical diffusion layer 12 on the end face of the optical transmission layer 16. Moreover, the signal light outgoing radiation section 14 is equipped with the 2nd optical diffusion layer 15 which diffuses the signal light which has spread the inside of the optical transmission layer 16, and carries out outgoing radiation from this signal light outgoing radiation section 14, and has pasted up this optical diffusion layer 15 on the end face of an opposite hand with the end face which the optical diffusion layer 12 of the optical transmission layer 16 pasted up.
[0011] Moreover, along with the end face 13 by the side of the signal light incidence section 11 of this optical bus 10, two or more light emitting devices (drawing 1 shows three light emitting devices 17, 18, and 19) are arranged. Along with the end face 23 by the side of the signal light outgoing radiation section 14 of this optical bus 10, two or more photo detectors (this drawing shows three photo detectors 20, 21, and 22) are arranged. A light emitting device and a photo detector Air was made to intervene and it has combined with the signal light incidence section 11 of the optical bus 10, and the signal light outgoing radiation section 14 optically, respectively. If outgoing radiation of the signal light is carried out from each light emitting device, incidence of this signal light is carried out to the signal light incidence section 11, and it is diffused towards the inside of the optical transmission layer 16 in the optical diffusion layer 12 with which the signal light incidence section 11 is equipped, will spread the inside of the optical transmission layer 16, will diffuse it in the optical diffusion layer 15 which the signal light outgoing radiation section 14 has, will carry out outgoing radiation from this signal light outgoing radiation section 14, and will be received by each photo detector.
[0012] The optical transmission layer 16 of this optical bus 10 is produced by PMMA (polymethylmethacrylate) fabricated by 1mm in thickness, and the square configuration of one side of 150mm die length. Moreover, the optical diffusion film which formed the acrylic resin layer with a thickness of 10 micrometers in which the pigment of a silica system was mixed on polyester film, and was produced is used for the optical diffusion layers 12 and 15 pasted up on the end face of the optical transmission layer 16, and the diffusion property of this optical diffusion film is almost equal to perfect diffusion distribution. A light emitting device is a laser diode with an oscillation wavelength [of 680nm], and an output reinforcement of 3mW, and a photo detector is Si photodiode of 0.7mm of diameters of light-receiving.
[0013] Thus, as for the constituted optical bus 10, the signal light outgoing radiation section 14 is equipped with the optical diffusion layer 15. In order to carry out total reflection of this signal light by this end face when signal light spreads by the larger incident angle than a critical angle to the end face by the side of the signal light outgoing radiation section of this optical bus if the optical bus which does not equip the signal light outgoing radiation section with the optical diffusion layer is considered here, In the optical bus 10 shown in drawing 1 although outgoing radiation of the signal light is not carried out from the signal light outgoing radiation section, that is, signal light is not received by the photo detector Since the signal light outgoing radiation section 14 is equipped with the optical diffusion layer 15 as mentioned above, even if the signal light spread in the signal light outgoing radiation section 14 from the optical transmission layer 16 spreads in the signal light outgoing radiation section 14 by the larger incident angle than a critical angle This

signal light is diffused in the optical diffusion layer 15 which the signal light outgoing radiation section 14 has, and outgoing radiation is carried out from this signal light outgoing radiation section 14. Therefore, signal light is received by any photo detector.

[0014] Moreover, since the signal light outgoing radiation section 14 is equipped with the optical diffusion layer 15 as mentioned above, this optical bus 10 diffuses with breadth the signal light which carried out incidence to the signal light outgoing radiation section 14 from the optical transmission layer 16 in the thickness direction of an optical bus, or the array direction of a photo detector. If the optical bus which does not equip the signal light outgoing radiation section with the optical diffusion layer is considered here The signal light spread almost vertically to this signal light outgoing radiation section among the signal light spread by the incident angle smaller than a critical angle to the end face by the side of the signal light outgoing radiation section of this optical bus Although outgoing radiation of the greater part of this signal light is carried out from the signal light outgoing radiation section and light is received by the photo detector since there is almost no reflective component in the signal light outgoing radiation section Even if signal light spreads almost vertically to the signal light outgoing radiation section 14, in the optical bus 10 shown in drawing 1 this signal light Since it is spread with breadth in the thickness direction of the optical bus 10, or the array direction of a photo detector, the signal luminous intensity received by the photo detector as compared with the optical bus which does not equip the signal light outgoing radiation section with the optical diffusion layer becomes small.

[0015] When the optical bus 10 shown in drawing 1 carries out outgoing radiation of the signal light from one certain light emitting device, dispersion in the signal luminous intensity received by each photo detector is controlled. Therefore, by this Even if it carries out incidence of the signal light from a light emitting device (for example, a light emitting device 17 and a light emitting device 19) which is different into this optical bus 10, dispersion of the signal luminous intensity received by one certain photo detector by the light emitting device is controlled.

[0016] In addition, although the optical diffusion layers 12 and 15 which the optical bus 10 shown in drawing 1 has form the acrylic resin layer in which the pigment of a silica system was mixed on polyester film and produced If refractive indexes with mutual pigment and resin layer differ, the combination of the ingredient of a pigment and the ingredient of a resin layer is arbitrary, as a pigment, can apply a rutile, a zinc white, etc. in addition to a silica, and can apply epoxy etc. as a resin layer besides an acrylic.

[0017] Moreover, although the optical diffusion film is used for the optical diffusion layers 12 and 15, the liquid crystallinity giant-molecule layer which except an optical diffusion film is sufficient as as long as an optical diffusion is shown, for example, was solidified in the state of random orientation may be used, or surface roughening of the end face by the side of the signal light outgoing radiation section of an optical bus may be carried out by the sandblasting method etc. Moreover, the inside of the signal light which the optical bus 10 shown in drawing 1 spreads the optical transmission layer 16, and is diffused in the optical diffusion layer 15, In order to receive the signal light which penetrates this optical diffusion layer 15 by the photo detector and to receive efficiently the signal light which spreads the optical transmission layer 16 by the photo detector As for the optical diffusion layer 15, what diffuses signal light so that larger reinforcement than the signal luminous intensity by which the signal luminous intensity which penetrates the optical diffusion layer 15 reflects by the optical diffusion layer 15, and goes to the optical transmission layer 16 interior may be shown is desirable.

[0018] Drawing 2 is the sectional view of the optical bus formed in the shape of [of the 2nd operation gestalt of this invention] a sheet. This sectional view is a sectional view of the thickness direction of an optical bus. This optical bus 40 has the optical transmission layer 46 which spreads the signal light which carried out incidence from the signal light incidence section 41 to which incidence of the signal light is carried out, the signal light outgoing radiation section 44 to which outgoing radiation of the signal light is carried out, and the signal light incidence section 41 in the signal light outgoing radiation section 44 and which makes optical bus 40 body. The signal light incidence section 41 is equipped with the optical diffusion layer 42 which turns to the optical transmission layer 46 the signal light by which incidence was carried out, and diffuses it, and has pasted up this optical diffusion layer 42 on the end face of the optical transmission layer 46. Moreover, with the signal light incidence section 41 side of the optical bus 40, the signal light outgoing radiation section 44 is formed in the opposite hand, reflected this signal light outgoing radiation section 44, diffusing the signal light which has spread the optical transmission layer 46, and is equipped with the optical diffusion layer 45 which carries out outgoing radiation from this signal light outgoing radiation section 44. With the end face which the optical diffusion layer 42 of the optical transmission layer 46 pasted up, the end face of an opposite hand is aslant cut to the table rear face of this

optical transmission layer 46, and the optical diffusion layer 45 with which the signal light outgoing radiation section 44 equips this end face cut aslant has pasted up.
[0019] Moreover, along with the end face 43 by the side of the signal light incidence section 41 of the optical bus 40, two or more light emitting devices (drawing 2 shows only one light emitting device 47) are arranged. In the upper part by the side of the signal light outgoing radiation section 44 of the optical bus 40 If two or more photo detectors (drawing 2 shows only one photo detector 48) are arranged and outgoing radiation of the signal light is carried out from a light emitting device 47 along with this signal light outgoing radiation section 44 Incidence of this signal light is carried out to the signal light incidence section 41, it is diffused towards the optical transmission layer 46 in the optical diffusion layer 42 with which the signal light incidence section 41 is equipped, and is spread in the signal light outgoing radiation section 44. It reflects being spread towards a photo detector 48 in the optical diffusion layer 45, and outgoing radiation of the signal light spread in this signal light outgoing radiation section 44 is carried out from this signal light outgoing radiation section 44, and it is received by the photo detector 48.
[0020] The signal light outgoing radiation section may be equipped with the optical diffusion layer which is made to reflect, making a photo detector turn and diffuse the signal light which has spread the inside of an optical transmission layer as shown in drawing 2 , and carries out outgoing radiation from this signal light outgoing radiation section. The inside of the signal light which the optical bus 40 shown in drawing 2 spreads the optical transmission layer 46, and is diffused in the optical diffusion layer 45, In order to receive the signal light reflected by this optical diffusion layer 45 by the photo detector and to receive efficiently the signal light which spreads the optical transmission layer 46 by the photo detector As for the optical diffusion layer 45, what diffuses signal light so that reinforcement with the larger signal luminous intensity which reflects the optical diffusion layer 45 than the signal luminous intensity which penetrates the optical diffusion layer 45 may be shown is desirable.
[0021] Drawing 3 is the configuration schematic diagram showing 1 operation gestalt of the signal processor of this invention. The optical bus 50 is being fixed to base 51 front face which constitutes the signal processor 60 shown in drawing 3 . This optical bus 50 carries out the laminating of what faced across the optical bus 10 shown in drawing 1 by the cladding layer 52, and the optical absorption layer 53 by turns, and is constituted. The signal processor 60 is equipped with a light emitting device 54, a photo detector 55 and the circuit board 57 in which the electronic circuitry 56 was carried, and the base fixed part 58. Moreover, this base fixed part 58 While the light emitting device 54 carried in the circuit board 57 is combined with the optical bus 50 in the signal light incidence section 11 of the optical bus 50, a photo detector 55 fixes to the condition of being combined with the optical bus 50, on a substrate 51 in the signal light outgoing radiation section 14 of the optical bus 50.
[0022] Thus, if the electrical signal processed in the electronic circuitry 56 is changed into signal light by the light emitting device 54, incidence of the constituted signal processor 60 will be carried out to the signal light incidence section 11, it will be diffused towards the optical transmission layer 16 in the optical diffusion layer 12 with which the signal light incidence section 11 is equipped, and will spread this signal light in the signal light outgoing radiation section 14. The signal light spread in this signal light outgoing radiation section 14 is diffused in the optical diffusion layer 15, and outgoing radiation is carried out from this signal light outgoing radiation section 14, and it is received by the photo detector 55. The signal light received by the photo detector 55 is changed into an electrical signal, and this electrical signal is inputted into the electronic circuitry 56 of another circuit board 57.
[0023] Since the optical bus 50 of this signal processor 60 is equipped with the cladding layer 52 and the optical absorption layer 53, the cross talk of the signal light between adjacent optical transmission layers is controlled. Moreover, since this signal processor 60 is equipped with the optical bus 50, there is little change of signal luminous intensity by the incidence location and outgoing radiation location of signal light by which outgoing radiation is carried out from the optical bus 50, the design of the electronic circuitry carried in the circuit board is easy, and improvement in S/N and a cost cut are achieved.
[0024] Furthermore, while each circuit board is fixed to a base fixed part, the signal processor of this invention is constituted so that the light emitting device and photo detector which were carried in the circuit board may be optically combined with an optical bus, and becomes unnecessary [delicate alignment].
[0025]
[Example] Hereafter, the example of this invention is explained. In the example shown here, the optical bus of a simple configuration of not equipping the signal light outgoing radiation section with the optical diffusion means was used by the example of a comparison using the optical bus shown in drawing 1 . Below the configuration of the optical bus of this example of a comparison is explained, and the experimental result

performed using the optical bus of an example and each example of a comparison is explained after that.
[0026] Drawing 4 is the top view showing the optical bus of the example of a comparison. In this description of drawing, the same sign as the sign given to drawing 1 is attached and shown in the same component as drawing 1 , and only a point of difference with drawing 1 is explained. The optical diffusion layer 15 with which the signal light outgoing radiation section 14 of the optical bus 10 which the signal light outgoing radiation section 31 of the optical bus 30, which shows the point of difference between drawing 1 and drawing 4 to drawing 4 shows to drawing 1 is equipped is only a point which it does not have.
[0027] Drawing 5 is a graph which shows the signal luminous intensity received by each photo detector shown in drawing 1 and drawing 4 . The distance between straight-line OO' and each photo detector which show the axis of abscissa of a graph to drawing 1 and drawing 4 in the optical bus of an example and each example of a comparison (A photo detector location, a call, and the distance between straight-line OO' and each light emitting device are hereafter called a light emitting device location) is shown. The axis of ordinate of a graph In the optical bus of an example and each example of a comparison, the signal luminous intensity received by each photo detector when carrying out outgoing radiation of the light is shown from the light emitting device (light emitting device 17 shown in drawing 1 and drawing 4) whose light emitting device location is 5mm. A black dot is a result when using the optical bus of an example, and a white round head is a result when using the optical bus of the example of a comparison.
[0028] By optical bus 30 of the example of a comparison, if the signal light spread in the signal light outgoing radiation section 31 from the optical transmission layer 16 spreads in the signal light outgoing radiation section 31 by the larger angle of incidence than a critical angle, total reflection of this signal light will be carried out by the end face 23 by the side of the signal light outgoing radiation section 31 of the optical bus 30. It is critical angle thetac about the signal light which the refractive index of the optical transmission layer 16 which the optical transmission layer 16 is manufactured by optical bus 30 of this example of a comparison using PMMA, and was manufactured using this PMMA is 1.49, and it is Mukai at the signal light outgoing radiation section 31 since the refractive index of air is about 1, and is spread. It becomes thetac =sin-1(1/1.49) =42.1 degree. Therefore, when outgoing radiation of the signal light is carried out from a light emitting device 17 by optical bus 30 of the example of a comparison, as it carries out total reflection of the signal light which goes to the signal light outgoing radiation section 31 by the larger incident angle than critical angle thetac =42.1 degree by the end face 23 by the side of the signal light outgoing radiation section 31, and it is shown in drawing 5 , in the photo detector which has a photo detector location in the location of 140mm or more, most signal luminous intensities received are zero. Moreover, since the reflective component in an end face 23 increases so that this incident angle approaches a critical angle even if it is the signal light which goes to the signal light outgoing radiation section 31 by the incident angle smaller than critical angle thetac =42.1 degree, as the array direction of a photo detector shows greatly the signal luminous intensity by which outgoing radiation is carried out from the signal light outgoing radiation section 31 to dispersion and drawing 5 , a photo detector location follows on becoming large, and the signal luminous intensity received by the photo detector becomes small.
[0029] Since, as for the optical bus 10 of an example, the signal light outgoing radiation section 14 is equipped with the optical diffusion layer 15 on the other hand, Even if the signal light spread in the signal light outgoing radiation section 14 from the optical transmission layer 16 spreads in the signal light outgoing radiation section 14 by the larger incident angle than a critical angle This signal light is diffused in the optical diffusion layer 15 which the signal light outgoing radiation section 14 has, outgoing radiation is carried out from this signal light outgoing radiation section 14, and as shown in drawing 5 , even if a photo detector location is a photo detector in the location of 140mm or more, signal light with a reinforcement of 1.5 microwatts - about 2.0 microwatts is received.
[0030] Moreover, since the signal light outgoing radiation section 14 is equipped with the optical diffusion layer 15 by optical bus 10 of an example, Although this signal light is diffused with breadth in the thickness direction of the optical bus 10, or the array direction of a photo detector according to the optical diffusion layer 15 even if it is the signal light which the signal light which is Mukai and is spread in the signal light outgoing radiation section 14 spreads almost vertically to this signal light outgoing radiation section 14 Since this signal light does not almost have a reflective component in an end face 23 and outgoing radiation of the greater part of this signal light is carried out from the signal light outgoing radiation section 31 by optical bus 30 of the example of a comparison, even if signal light spreads almost vertically to the signal light outgoing radiation section 31, The signal luminous intensity by which the optical bus 10 of an example is received by the photo detector as compared with the optical bus 30 of the example of a comparison becomes small. By optical bus 10 of an example 1, as shown in drawing 5 , the signal luminous intensity by

which a photo detector location is received by the photo detector rather than the optical bus 30 of the example of a comparison in 0 to 80mm is small. From the graph of drawing 5 , the optical bus 10 of an example is understood that dispersion in the signal luminous intensity by the photo detector location received is smaller than the optical bus 30 of the example of a comparison.

[0031] Drawing 6 is a graph which shows the signal luminous intensity received by one certain photo detector at the time of carrying out outgoing radiation of the signal light from each light emitting device shown in drawing 1 and drawing 4 . The axis of abscissa of a graph shows the light emitting device location of the light emitting device located in a line along with the signal light incidence section in the optical bus of an example and each example of a comparison, and the axis of ordinate of a graph shows the signal luminous intensity received by the photo detector (photo detector 20 shown in drawing 1 and drawing 4) whose photo detector location when carrying out outgoing radiation of the light from each light emitting device is 5mm in the optical bus of an example and each example of a comparison. A black dot is a result when using the optical bus of an example, and a white round head is a result when using the optical bus of the example of a comparison.

[0032] When a light emitting device location carries out outgoing radiation of the signal light by optical bus 30 of the example of a comparison from the light emitting device which is 135mm, as shown in drawing 6 Even if most signal luminous intensities received by the photo detector whose photo detector location is 145mm are zero and it is the signal light which goes to the signal light outgoing radiation section 31 by the incident angle smaller than critical angle thetac =42.1 degree Since the reflective component in an end face 23 increases so that this incident angle approaches a critical angle, as a light emitting device location shows greatly the signal luminous intensity received by the photo detector to dispersion and drawing 6 , a light emitting device location follows on becoming large, and the signal luminous intensity received by the photo detector becomes small.

[0033] Since, as for the optical bus 10 of an example, the signal light outgoing radiation section 14 is equipped with the optical diffusion layer 15 on the other hand, Even if the signal light spread in the signal light outgoing radiation section 14 from the optical transmission layer 16 spreads in the signal light outgoing radiation section 14 by the larger incident angle than a critical angle This signal light is diffused in the optical diffusion layer 15 which the signal light outgoing radiation section 14 has, outgoing radiation is carried out from this signal light outgoing radiation section 14, and as shown in drawing 6 , even if a light emitting device location is a light emitting device in the location which is 145mm, signal light with a reinforcement of about 1 microwatt is received.

[0034] Moreover, although it is spread with breadth in the thickness direction of the optical bus 10, or the array direction of a photo detector according to the optical diffusion layer 15 by optical bus 10 of an example even if signal light spreads almost vertically to the signal light outgoing radiation section 14 If signal light spreads almost vertically to the signal light outgoing radiation section 31, since this signal light will not almost have a reflective component in an end face 23 and outgoing radiation of the greater part of this signal light will be carried out from the signal light outgoing radiation section 31 by optical bus 30 of the example of a comparison, The signal luminous intensity by which the optical bus 10 of an example is received by the photo detector as compared with the optical bus 30 of the example of a comparison becomes small. By optical bus 10 of an example 1, as shown in drawing 6 , the signal luminous intensity by which a light emitting device location is received by the photo detector rather than the optical bus 30 of the example of a comparison in 0 to 75mm is small. From the graph of drawing 6 , the optical bus 10 shown in drawing 1 is understood that dispersion of the signal luminous intensity received by the photo detector by the light emitting device location is smaller than the optical bus 30 of the example of a comparison.

[0035] The result shown in the graph of drawing 5 and drawing 6 shows that improvement in S/N and the signal processor with which the cost cut was achieved are obtained by using the optical bus of this invention.

[0036]

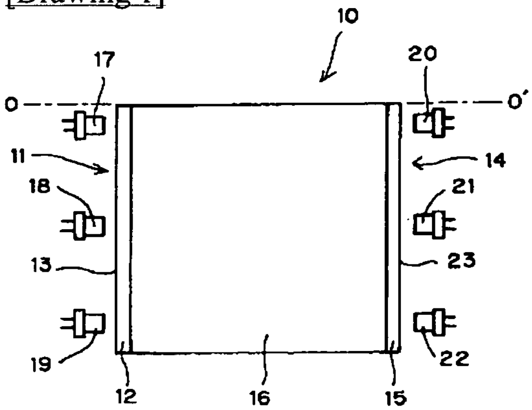
[Effect of the Invention] As explained above, even if there is a temperature change etc., according to the optical bus of this invention, outgoing radiation of the signal light which carried out incidence from the signal light incidence section is certainly carried out from the signal light outgoing radiation section. Moreover, according to the optical bus of this invention, there is little change of signal luminous intensity by the incidence location and outgoing radiation location of signal light by which outgoing radiation is carried out.

[0037] Moreover, according to the signal processor of this invention, improvement in S/N and a cost cut are achieved.

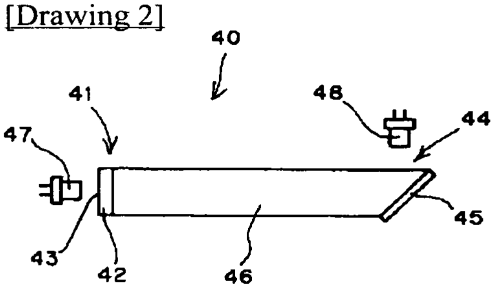
[Translation done.]

DRAWINGS

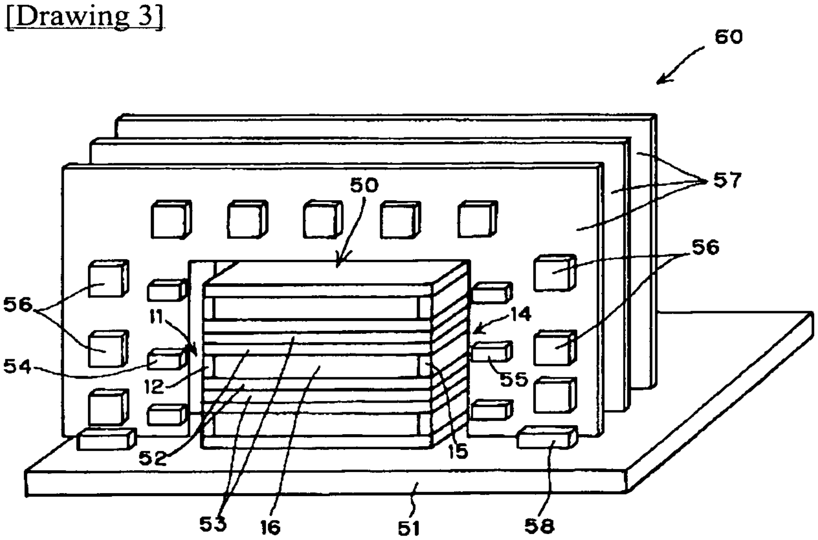
[Drawing 1]



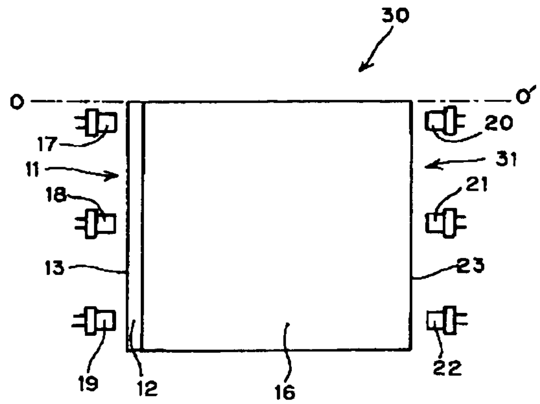
[Drawing 2]



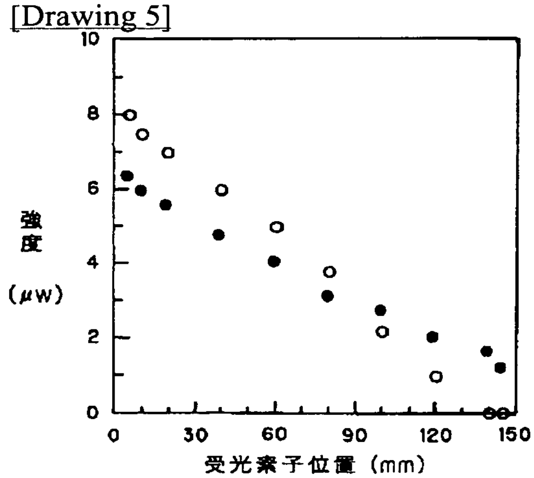
[Drawing 3]



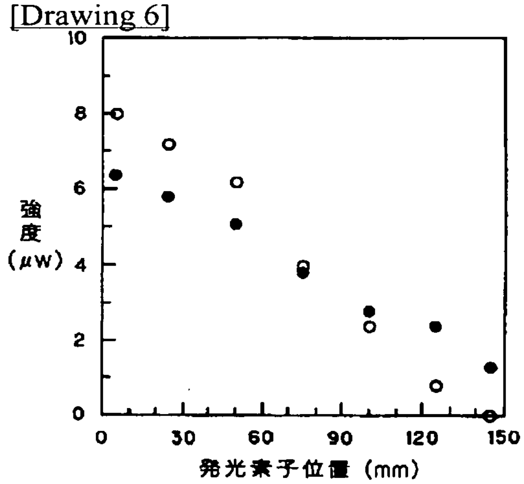
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]

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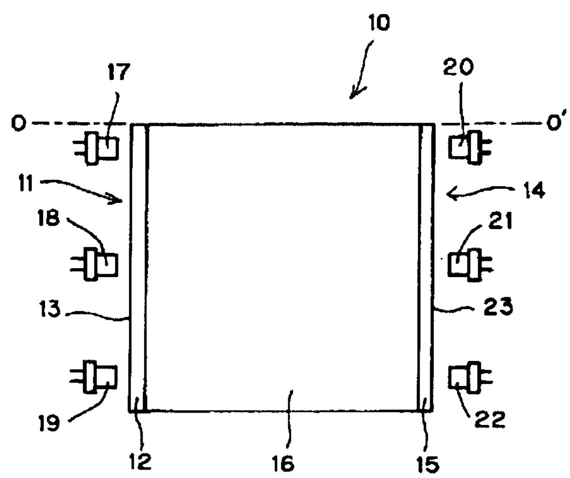
(54)【発明の名称】　光バスおよび信号処理装置

(57)【要約】

【課題】埃等に対する耐性が高く、温度変化等の環境変化にも強く、システムの拡張性に応じて回路基板の自由な着脱が容易に可能な光バス、およびその光バスを採用した信号処理装置を提供する。

【解決手段】光バス１０が有する信号光出射部１４に、光伝送層１６を伝播してきた信号光を拡散してこの信号光出射部１４から出射する光拡散層１５を備える。



【特許請求の範囲】

【請求項1】 信号光が入射される信号光入射部と、信号光が出射される信号光出射部と、前記信号光入射部から入射した信号光を信号光出射部に伝播する光バス本体とを有する光バスであって、
前記信号光入射部が、入射した信号光を光バス本体内に向けて拡散する第1の光拡散手段を備えるとともに、
前記信号光出射部が、光バス本体内を伝播してきた信号光を拡散して該信号光出射部から出射する第2の光拡散手段を備えたことを特徴とする光バス。

【請求項2】 基体、
信号光を出射する信号光出射端および該信号光出射端から出射される信号光に担持させる信号を生成する回路が搭載された第1の回路基板、
信号光を入射する信号光入射端および該信号光入射端から入射した信号光が担持する信号に基づいて信号処理を行なう回路が搭載された第2の回路基板、
前記基体に固定された、信号光が入射される信号光入射部と、信号光が出射される信号光出射部と、前記信号光入射部から入射した信号光を信号光出射部に伝搬する光バス本体とを有し、前記信号光入射部が、入射した信号光を光バス本体内に向けて拡散する第1の光拡散手段を備え、前記信号光出射部が、光バス本体内を伝播してきた信号光を拡散してこの信号光出射部から出射する第2の光拡散手段を備えてなる光バス、および、
前記第1の回路基板および前記第2の回路基板を、前記第1の回路基板に搭載された信号光出射端が前記信号光入射部において前記光バスと結合されるとともに、前記第2の回路基板に搭載された信号光入射端が前記信号光出射部において前記光バスと結合される状態に前記基体上に固定する基体固定部を備えたことを特徴とする信号処理装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、光信号の伝播を担う光バス、およびその光バスを用いたデータの送受を含む信号処理を行なう信号処理装置に関する。

【0002】

【従来の技術】超大規模集積回路（ＶＬＳＩ）の開発により、データ処理システムで使用する回路基板（ドーターボード）の回路機能が大幅に増大してきている。回路機能が増大するにつれて各回路基板に対する信号接続数が増大するため、各回路基板（ドーターボード）間をバス構造で接続するデータバスボード（マザーボード）には多数の接続コネクタと接続線を必要とする並列アーキテクチャが採用されてきている。接続線の多層化と微細化による並列化を進めることにより並列バスの動作速度の向上が図られてきたが、接続配線間容量や接続配線抵抗に起因する信号遅延により、システムの処理速度が並列バスの動作速度によって制限されることもある。また、並列バス接続配線の高密度化による電磁ノイズ（ＥＭＩ：Ｅｌｅｃｔｒｏｍａｇｎｅｔｉｃ Ｉｎｔｅｒｆｅｒｅｎｃｅ）の問題もシステムの処理速度向上に対する大きな制約となる。

【０００３】このような問題を解決し並列バスの動作速度の向上を図るために、光インターコネクションと呼ばれる、システム内光接続技術を用いることが検討されている。光インターコネクション技術の概要は、『内田禎二、第９回 回路実装学術講演大会 １５Ｃ０１，ｐｐ．２０１～２０２』や『Ｈ．Ｔｏｍｉｍｕｒｏ ｅｔ ａｌ．，“Ｐａｃｋａｇｉｎｇ Ｔｅｃｈｎｏｌｏｇｙ ｆｏｒ Ｏｐｔｉｃａｌ Ｉｎｔｅｒｃｏｎｎｅｃｔｓ”，ＩＥＥＥ Ｔｏｋｙｏ Ｎｏ．３３ ｐｐ．８１～８６，１９９４』、『和田修、エレクトロニクス１９９３年４月号、ｐｐ．５２～５５』に記載されているように、システムの構成内容により様々な形態の技術が提案されている。

【０００４】

【発明が解決しようとする課題】従来提案された様々な形態の光インターコネクション技術のうち、特開平２－４１０４２号公報には、高速、高感度の発光／受光デバイスを用いた光データ伝送方式をデータバスに適用した例が開示されており、そこには、各回路基板の表裏両面に発光／受光デバイスを配置し、システムフレームに組み込まれた隣接する回路基板上の発光／受光デバイス間を空間的に光で結合した、各回路基板相互間のループ伝送用の直列光データバスが提案されている。この方式では、ある１枚の回路基板から送り出された信号光が、隣接する回路基板で光／電気変換され、さらにその回路基板で今度は電気／光変換されて、次に隣接する回路基板に信号光を送り出すというように、各回路基板が順次直列に配列され各回路基板上で光／電気変換および電気／光変換を繰り返しながらシステムフレームに組み込まれたすべての回路基板間に伝達される。このため、信号伝達速度は各回路基板上に配置された受光／発光デバイスの光／電気変換速度および電気／光変換速度に依存すると同時にその制約を受ける。また、各回路基板相互間のデータ伝送には、各回路基板上に配置された受光／発光デバイスによる、自由空間を介在させた光結合を用いているため、隣接する回路基板表裏両面に配置されている発光／受光デバイスの光学的位置合わせが行なわれすべての回路基板が光学的に結合していることが必要となる。さらに、各回路基板が自由空間を介して結合されているため、隣接する光データ伝送路間の干渉（クロストーク）が発生しデータの伝送不良が予想される。また、システムフレーム内の環境、例えば埃などにより信号光が拡散することによりデータの伝送不良が発生することも予想される。さらに、各回路基板が直列に配置されているため、いずれかのボードが取り外された場合にはそこで接続が途切れてしまうので、それを補うための余分

な回路基板が必要となる。すなわち、回路基板を自由に着脱することができず、回路基板の数が固定されてしまうという問題がある。

【０００５】これらのほかに、自由空間を利用した回路基板相互間のデータ伝送技術として、特開昭６１－１９６２１０号公報には、平行な２面を有する、光源に対置されたプレートを具備し、プレート表面に配置された回折格子および反射素子により構成された光路を介して回路基板間を光学的に結合する方式が開示されている。この方式では、１点から発せられた光を固定された１点にしか伝送することができず、電気バスのように全ての回路ボード間を網羅的に接続することができないという問題がある。また、自由空間を利用しているので複雑な光学系が必要となり、位置合わせ等も難しいため、光学素子の位置ずれに起因する、隣接する光伝送路間の干渉（クロストーク）が発生し、データの伝送不良が予想される。さらに、回路基板間の接続情報はプレート表面に配置された回折格子および反射素子により決定されるため、回路基板を自由に抜き差しすることができず拡張性が低いというような様々な問題がある。

【０００６】本発明は、上記事情に鑑み、埃等に対する耐性が高く、温度変化等の環境変化にも強く、システムの拡張性に応じて回路基板の自由な着脱が容易に可能な光バス、およびその光バスを採用した信号処理装置を提供することを目的とする。

【０００７】

【課題を解決するための手段】上記目的を達成する手段として、入射した信号光を拡散して伝播する光バスを採用することが考えられるが、このような光バスを単純に作製すると、信号光の入射位置によって、ある１つの出射位置から出射される信号光の強度が大きくばらつき、ダイナミックレンジの広い信号光を検出する必要を生じる恐れがある。そのため、その広いダイナミックレンジに適合した回路設計を行う必要があるが、広いダイナミックレンジに適合した回路設計は大変であり、Ｓ／Ｎの低下や、コストアップを招くという問題がある。

【０００８】そこで、本発明の光バスは、上記目的を達成するとともに、さらに、信号光の入射位置や出射位置による、出射される信号光の強度の変化を少なくする光バスであって、信号光が入射される信号光入射部と、信号光が出射される信号光出射部と、上記信号光入射部から入射した信号光を信号光出射部に伝播する光バス本体とを有する光バスであって、上記信号光入射部が、入射された信号光を光バス本体内に向けて拡散する光拡散手段を備えるとともに、上記信号光出射部が、光バス本体内を伝播してきた信号光を拡散してこの信号光出射部から出射する光拡散手段を備えたことを特徴とする。

【０００９】また、本発明の信号処理装置は、

（１）基体

（２）信号光を出射する信号光出射端および該信号光出射端から出射される信号光に担持される信号を生成する回路が搭載された第１の回路基板

（３）信号光を入射する信号光入射端および該信号光入射端から入射した信号光が担持する信号に基づいて信号処理を行なう回路が搭載された第２の回路基板

（４）上記基体に固定された、信号光が入射される信号光入射部と、信号光が出射される信号光出射部と、上記信号光入射部から入射した信号光を信号光出射部に伝搬する光バス本体とを有し、上記信号光入射部が、入射された信号光を光バス本体内に向けて拡散する光拡散手段を備え、上記信号光出射部が、光バス本体内を伝播してきた信号光を拡散してこの信号光出射部から出射する光拡散手段を備えてなる光バス

（５）上記第１の回路基板および上記第２の回路基板を、上記第１の回路基板に搭載された信号光出射端が上記信号光入射部において上記光バスと結合されるとともに、上記第２の回路基板に搭載された信号光入射端が上記信号光出射部において上記光バスと結合される状態に上記基体上に固定する基体固定部

を備えたことを特徴とする。

【００１０】

【発明の実施の形態】以下、本発明の実施形態について説明する。図１は、本発明の第１実施形態の光バスを示す平面図である。この光バス１０は、信号光が入射される信号光入射部１１と、信号光が出射される信号光出射部１４と、信号光入射部１１から入射した信号光を信号光出射部１４に伝播する、光バス１０本体をなす光伝送層１６とを有している。信号光入射部１１は、入射した信号光を光伝送層１６に向けて拡散する第１の光拡散層１２を備えており、この光拡散層１２は光伝送層１６の端面に接着されている。また、信号光出射部１４は、光伝送層１６内を伝播してきた信号光を拡散してこの信号光出射部１４から出射する第２の光拡散層１５を備えており、この光拡散層１５は、光伝送層１６の、光拡散層１２が接着された端面とは反対側の端面に接着されている。

【００１１】また、この光バス１０の信号光入射部１１側の端面１３に沿って、複数の発光素子（図１では３つの発光素子１７，１８，１９を示す）が配列され、この光バス１０の信号光出射部１４側の端面２３に沿って、複数の受光素子（この図では３つの受光素子２０，２１，２２を示す）が配列されており、発光素子、受光素子は、空気を介在させて、それぞれ光バス１０の信号光入射部１１、信号光出射部１４と光学的に結合している。各発光素子から信号光が出射されると、この信号光は信号光入射部１１に入射し、信号光入射部１１が備えている光拡散層１２で光伝送層１６内に向けて拡散されて光伝送層１６内を伝播し、信号光出射部１４が有する光拡散層１５で拡散してこの信号光出射部１４から出射し、各受光素子で受光される。

【００１２】この光バス１０の光伝送層１６は、厚さ１mm、一辺の長さ１５０mmの正方形状に成形されたPMMA（ポリメチルメタクリレート）で作製されている。また、光伝送層１６の端面に接着された光拡散層１２，１５には、シリカ系の顔料が混入された厚さ１０μmのアクリル系樹脂層をポリエステルフィルム上に形成して作製された光拡散フィルムを用いており、この光拡散フィルムの拡散特性は完全拡散分布にほぼ等しい。発光素子は、発振波長６８０nm、出力強度３mWのレーザダイオードであり、受光素子は受光径０．７mmのSiフォトダイオードである。

【００１３】このように構成された光バス１０は、信号光出射部１４が光拡散層１５を備えている。ここで、信号光出射部に光拡散層を備えていない光バスについて考えると、この光バスの信号光出射部側の端面に臨界角よりも大きい入射角で信号光が伝播する場合、この信号光はこの端面で全反射するため、信号光出射部から信号光は出射されず、つまり受光素子で信号光は受光されないが、図１に示す光バス１０においては、上記のように信号光出射部１４が光拡散層１５を備えているため、光伝送層１６から信号光出射部１４に伝播する信号光が臨界角よりも大きい入射角で信号光出射部１４に伝播しても、この信号光は信号光出射部１４が有する光拡散層１５で拡散されてこの信号光出射部１４から出射される。従って、いずれの受光素子でも信号光が受光される。

【００１４】また、この光バス１０は、上記のように信号光出射部１４が光拡散層１５を備えているため、光伝送層１６から信号光出射部１４に入射した信号光は、光バスの厚さ方向や受光素子の配列方向に広がりながら拡散する。ここで、信号光出射部に光拡散層を備えていない光バスについて考えると、この光バスの信号光出射部側の端面に臨界角よりも小さい入射角で伝播する信号光のうち、この信号光出射部に対してほぼ垂直に伝播する信号光は、信号光出射部での反射成分がほとんどないため、この信号光の大部分は信号光出射部から出射されて受光素子で受光されるが、図１に示す光バス１０においては、信号光が信号光出射部１４に対しほぼ垂直に伝播しても、この信号光は、光バス１０の厚さ方向や受光素子の配列方向に広がりながら拡散するため、信号光出射部に光拡散層を備えていない光バスと比較すると、受光素子で受光される信号光の強度は小さくなる。

【００１５】従って、図１に示す光バス１０は、ある１つの発光素子から信号光を出射した場合、各受光素子で受光される信号光の強度のばらつきが抑制され、これにより、この光バス１０に、異なる発光素子（例えば、発光素子１７と、発光素子１９）から信号光を入射しても、発光素子による、ある１つの受光素子で受光される信号光の強度のばらつきが抑制される。

【００１６】尚、図１に示す光バス１０が有する光拡散層１２，１５は、シリカ系の顔料が混入されたアクリル系樹脂層をポリエステルフィルム上に形成して作製されているが、顔料および樹脂層は、互いの屈折率が異なっていれば、顔料の材料と樹脂層の材料との組合せは任意であり、顔料としては、シリカ以外にルチル、亜鉛華などが適用でき、樹脂層としてはアクリル以外にもエポキシなどが適用できる。

【００１７】また、光拡散層１２，１５には、光拡散フィルムが用いられているが、光拡散作用を示すものであれば光拡散フィルム以外でもよく、例えば、ランダム配向状態で固化した液晶性高分子層を用いたり、光バスの信号光出射部側の端面をサンドブラスト法などによって粗面化してもよい。また、図１に示す光バス１０は、光伝送層１６を伝播し光拡散層１５で拡散する信号光のうちの、この光拡散層１５を透過する信号光を受光素子で受光しており、光伝送層１６を伝播する信号光が効率よく受光素子で受光されるためには、光拡散層１５は、光拡散層１５を透過する信号光の強度が、光拡散層１５で反射し光伝送層１６内部に向かう信号光の強度より大きい強度を示すように信号光を拡散させるものが好ましい。

【００１８】図２は、本発明の第２実施形態のシート状に形成された光バスの断面図である。この断面図は、光バスの厚さ方向の断面図である。この光バス４０は、信号光が入射される信号光入射部４１と、信号光が出射される信号光出射部４４と、信号光入射部４１から入射した信号光を信号光出射部４４に伝播する、光バス４０本体をなす光伝送層４６とを有している。信号光入射部４１は、入射された信号光を光伝送層４６に向けて拡散する光拡散層４２を備えており、この光拡散層４２は、光伝送層４６の端面に接着されている。また、信号光出射部４４は、光バス４０の信号光入射部４１側とは反対側に設けられており、この信号光出射部４４は、光伝送層４６を伝播してきた信号光を拡散しながら反射させ、この信号光出射部４４から出射する光拡散層４５を備えている。光伝送層４６の、光拡散層４２が接着された端面とは反対側の端面は、この光伝送層４６の表裏面に対し斜めにカットされており、この斜めにカットされた端面に、信号光出射部４４が備えている光拡散層４５が接着されている。

【００１９】また、光バス４０の信号光入射部４１側の端面４３に沿って、複数の発光素子（図２では１つの発光素子４７のみを示す）が配列され、光バス４０の信号光出射部４４側の上方には、この信号光出射部４４に沿って、複数の受光素子（図２では１つの受光素子４８のみを示す）が配列されており、発光素子４７から信号光が出射されると、この信号光は信号光入射部４１に入射し、信号光入射部４１が備えている光拡散層４２で光伝送層４６に向けて拡散され、信号光出射部４４に伝播する。この信号光出射部４４に伝播してきた信号光は、光拡散層４５で受光素子４８に向けて拡散しながら反射し

てこの信号光出射部４４から出射され、受光素子４８で受光される。

【００２０】信号光出射部は、図２に示すように、光伝送層内を伝播してきた信号光を受光素子に向けて拡散させながら反射させてこの信号光出射部から出射する光拡散層を備えてもよい。図２に示す光バス４０は、光伝送層４６を伝播し光拡散層４５で拡散する信号光のうちの、この光拡散層４５で反射する信号光を受光素子で受光しており、光伝送層４６を伝播する信号光が効率よく受光素子で受光されるためには、光拡散層４５は、光拡散層４５を反射する信号光の強度が、光拡散層４５を透過する信号光の強度より大きい強度を示すように信号光を拡散させるものが好ましい。

【００２１】図３は、本発明の信号処理装置の一実施形態を示す構成概略図である。図３に示す信号処理装置６０を構成する基体５１表面には光バス５０が固定されている。この光バス５０は、図１に示す光バス１０をクラッド層５２で挟んだものと、光吸収層５３とを交互に積層して構成されている。また、信号処理装置６０は、発光素子５４、受光素子５５、および電子回路５６が搭載された回路基板５７と、基体固定部５８とを備えており、この基体固定部５８は、回路基板５７に搭載された発光素子５４が光バス５０の信号光入射部１１において光バス５０と結合されるとともに、受光素子５５が光バス５０の信号光出射部１４において、光バス５０と結合される状態に基板５１上に固定する。

【００２２】このように構成された信号処理装置６０は、電子回路５６で処理された電気信号が発光素子５４で信号光に変換されると、この信号光は信号光入射部１１に入射し、信号光入射部１１が備えている光拡散層１２で光伝送層１６に向けて拡散され、信号光出射部１４に伝播する。この信号光出射部１４に伝播してきた信号光は、光拡散層１５で拡散してこの信号光出射部１４から出射され、受光素子５５で受光される。受光素子５５で受光された信号光は、電気信号に変換され、この電気信号は、別の回路基板５７の電子回路５６に入力される。

【００２３】この信号処理装置６０の光バス５０は、クラッド層５２および光吸収層５３を備えているため、隣り合う光伝送層間の信号光のクロストークが抑制される。また、この信号処理装置６０は、光バス５０を備えているため、信号光の入射位置や出射位置による、光バス５０から出射される信号光の強度の変化は少なく、回路基板に搭載される電子回路の設計が容易であり、Ｓ／Ｎの向上や、コストダウンが図られる。

【００２４】さらに、本発明の信号処理装置は、回路基板それぞれが基体固定部に固定されると同時に、その回路基板に搭載された発光素子および受光素子が光バスと光学的に結合されるように構成され、微妙な位置合わせは不要となる。

【００２５】

【実施例】以下、本発明の実施例について説明する。ここに示す実施例では図１に示す光バスを用い、比較例では、信号光出射部に光拡散手段を備えていない単純な構成の光バスを用いた。以下に、この比較例の光バスの構成について説明し、その後、実施例、比較例それぞれの光バスを用いて行なった実験結果について説明する。

【００２６】図４は、比較例の光バスを示す平面図である。この図の説明にあたっては、図１と同一の構成要素には図１に付した符号と同一の符号を付して示し、図１との相違点のみについて説明する。図１と図４との相違点は、図４に示す光バス３０の信号光出射部３１が、図１に示す光バス１０の信号光出射部１４が備えている光拡散層１５は備えていない点のみである。

【００２７】図５は、図１、図４に示す各受光素子で受光される信号光の強度を示すグラフである。グラフの横軸は、実施例、比較例それぞれの光バスにおいて、図１、図４に示す直線ＯＯ’と各受光素子との間の距離（以下、受光素子位置と呼び、また、直線ＯＯ’と各発光素子との間の距離を発光素子位置と呼ぶ）を示しており、グラフの縦軸は、実施例、比較例それぞれの光バスにおいて、発光素子位置が５ｍｍである発光素子（図１，図４に示す発光素子１７）から光を出射した時の各受光素子で受光された信号光の強度を示す。黒丸は、実施例の光バスを用いたときの結果であり、白丸は比較例の光バスを用いたときの結果である。

【００２８】比較例の光バス３０では、光伝送層１６から信号光出射部３１に伝播する信号光が臨界角よりも大きい入射角で信号光出射部３１に伝播すると、この信号光は、光バス３０の、信号光出射部３１側の端面２３で全反射する。この比較例の光バス３０では、光伝送層１６はＰＭＭＡを用いて製造されており、このＰＭＭＡを用いて製造された光伝送層１６の屈折率は１．４９であり、また、空気の屈折率はほぼ１であるから、信号光出射部３１に向かって伝播する信号光に関する臨界角θ_cは、$\theta_c = \sin^{-1}(1/1.49) = 42.1°$となる。従って、臨界角$\theta_c = 42.1°$よりも大きい入射角で信号光出射部３１に向かう信号光は信号光出射部３１側の端面２３で全反射し、比較例の光バス３０では、発光素子１７から信号光を出射した場合、図５に示すように、受光素子位置が１４０ｍｍ以上の位置にある受光素子では、受光される信号光の強度はほとんどゼロである。また、臨界角$\theta_c = 42.1°$よりも小さい入射角で信号光出射部３１に向かう信号光であっても、この入射角が臨界角に近づく程、端面２３での反射成分が増大するため、信号光出射部３１から出射される信号光の強度は、受光素子の配列方向で大きくばらつき、図５に示すように、受光素子位置が大きくなるに伴ない、受光素子で受光される信号光の強度は小さくなる。

【００２９】一方、実施例の光バス１０は、信号光出射

部１４が光拡散層１５を備えているため、光伝送層１６から信号光出射部１４に伝播する信号光が臨界角よりも大きい入射角で信号光出射部１４に伝播しても、この信号光は信号光出射部１４が有する光拡散層１５で拡散されてこの信号光出射部１４から出射され、図５に示すように、受光素子位置が１４０ｍｍ以上の位置にある受光素子であっても、１．５μＷ～２．０μＷ程度の強度の信号光が受光されている。

【００３０】また、実施例の光バス１０では、信号光出射部１４が光拡散層１５を備えているため、信号光出射部１４に向かって伝播する信号光がこの信号光出射部１４に対してほぼ垂直に伝播する信号光であっても、この信号光は、光拡散層１５により光バス１０の厚さ方向や受光素子の配列方向に広がりながら拡散するが、比較例の光バス３０では、信号光が信号光出射部３１に対してほぼ垂直に伝播しても、この信号光は端面２３での反射成分がほとんどなく、この信号光の大部分は信号光出射部３１から出射されるため、実施例の光バス１０は、比較例の光バス３０と比較すると、受光素子で受光される信号光の強度は小さくなる。実施例１の光バス１０では、図５に示すように、受光素子位置が０ｍｍから８０ｍｍの範囲では、比較例の光バス３０よりも受光素子で受光される信号光の強度が小さくなっている。図５のグラフから、実施例の光バス１０は、比較例の光バス３０よりも、受光素子位置による、受光される信号光の強度のばらつきが小さいことがわかる。

【００３１】図６は、図１、図４に示す各発光素子から信号光を出射した際の、ある一つの受光素子で受光された信号光の強度を示すグラフである。グラフの横軸は、実施例、比較例それぞれの光バスにおいて、信号光入射部に沿って並ぶ発光素子の発光素子位置を示しており、グラフの縦軸は、実施例、比較例それぞれの光バスにおいて、各発光素子から光を出射したときの、受光素子位置が５ｍｍである受光素子（図１，図４に示す受光素子２０）で受光された信号光の強度を示す。黒丸は、実施例の光バスを用いたときの結果であり、白丸は比較例の光バスを用いたときの結果である。

【００３２】比較例の光バス３０では、発光素子位置が１３５ｍｍである発光素子から信号光を出射した場合、図６に示すように、受光素子位置が１４５ｍｍである受光素子で受光される信号光の強度はほとんどゼロであり、また、臨界角θ_c＝４２．１°よりも小さい入射角で信号光出射部３１に向かう信号光であっても、この入射角が臨界角に近づく程、端面２３での反射成分が増大するため、受光素子で受光される信号光の強度は、発光素子位置により大きくばらつき、図６に示すように、発光素子位置が大きくなるに伴ない、受光素子で受光される信号光の強度は小さくなる。

【００３３】一方、実施例の光バス１０は、信号光出射部１４が光拡散層１５を備えているため、光伝送層１６から信号光出射部１４に伝播する信号光が臨界角よりも大きい入射角で信号光出射部１４に伝播しても、この信号光は信号光出射部１４が有する光拡散層１５で拡散されてこの信号光出射部１４から出射され、図６に示すように、発光素子位置が１４５ｍｍの位置にある発光素子であっても、１μＷ程度の強度の信号光が受光されている。

【００３４】また、実施例の光バス１０では、信号光出射部１４に対してほぼ垂直に信号光が伝播しても、光拡散層１５により光バス１０の厚さ方向や受光素子の配列方向に広がりながら拡散するが、比較例の光バス３０では、信号光出射部３１に対してほぼ垂直に信号光が伝播すると、この信号光は端面２３での反射成分がほとんどなく、この信号光の大部分は信号光出射部３１から出射されるため、実施例の光バス１０は、比較例の光バス３０と比較すると、受光素子で受光される信号光の強度は小さくなる。実施例１の光バス１０では、図６に示すように、発光素子位置が０ｍｍから７５ｍｍの範囲では、比較例の光バス３０よりも受光素子で受光される信号光の強度が小さくなっている。図６のグラフから、図１に示す光バス１０は、比較例の光バス３０よりも、発光素子位置による、受光素子で受光される信号光の強度のばらつきが小さいことがわかる。

【００３５】図５、図６のグラフに示した結果から、本発明の光バスを用いることにより、Ｓ／Ｎの向上や、コストダウンが図られた信号処理装置が得られることがわかる。

【００３６】

【発明の効果】以上説明したように、本発明の光バスによれば、温度変化等があっても信号光入射部から入射した信号光は確実に信号光出射部から出射される。また、本発明の光バスによれば、信号光の入射位置や出射位置による、出射される信号光の強度の変化は少ない。

【００３７】また、本発明の信号処理装置によれば、Ｓ／Ｎの向上や、コストダウンが図られる。

【図面の簡単な説明】

【図１】本発明の第１実施形態の光バスを示す平面図である。

【図２】本発明の第２実施形態の光バスの断面図である。

【図３】本発明の信号処理装置の一実施形態を示す構成概略図である。

【図４】信号光出射部に光拡散層をもたない光バスを示す平面図である。

【図５】図１、図４に示す各受光素子で受光される信号光の強度を示すグラフである。

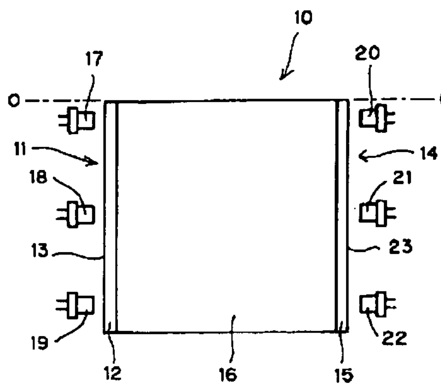
【図６】図１、図４に示す各発光素子から信号光を出射した際の、ある一つの受光素子で受光される信号光の強度を示すグラフである。

【符号の説明】

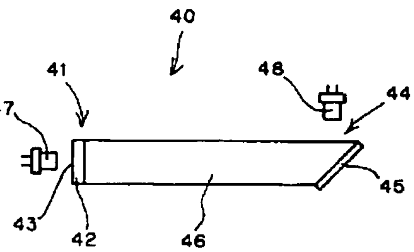
10，40，50　光バス
11，41　信号光入射部
12，15，42，45　光拡散層
13，23，43　端面
14，44　信号光出射部
16，46　光伝送層
17，18，19，47，54　発光素子

20，21，22，48，55　受光素子
51　基板
52　クラッド層
53　光吸収層
56　電子回路
57　回路基板
58　基体固定部

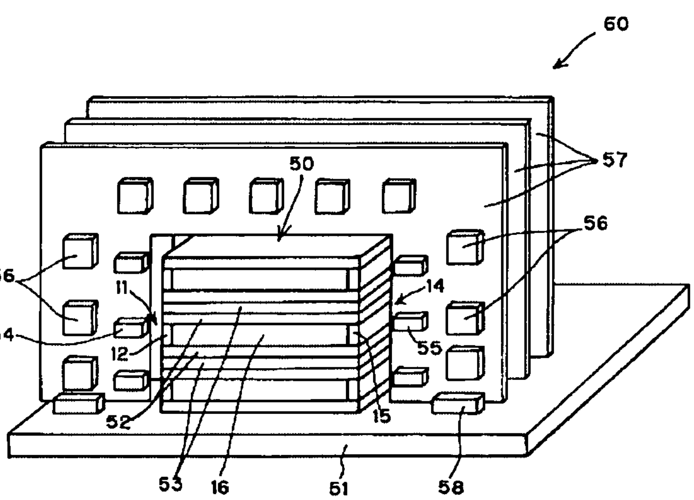
【図1】



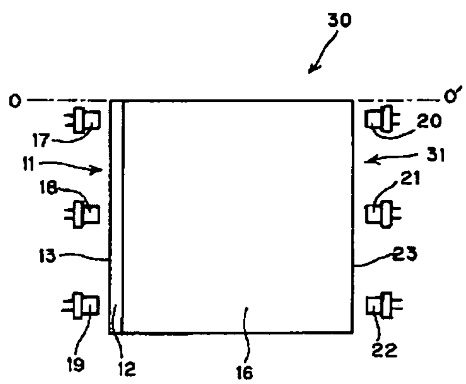
【図2】



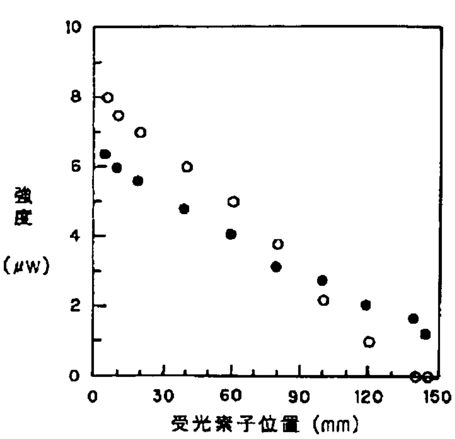
【図3】



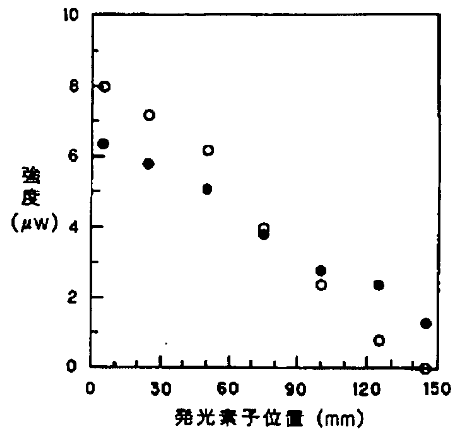
【図4】



【図5】



【図6】



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